RELATEDNESS AND MORTALITY AMONG THE JAMESTOWN COLONY SETTLERS

by

Teresa Potter

A dissertation submitted to the faculty of
The University of Utah
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

Department of Anthropology

The University of Utah

August 2012

The University of Utah Graduate School

STATEMENT OF DISSERTATION APPROVAL

The dissertation of **Teresa Potter**

has been approved by the following supervisory committee members:

John McCullough	, Chair	**4/9/2012** Date Approved
Dennis O'Rourke	, Member	**4/9/2012** Date Approved
Henry Harpending	, Member	**4/4/2012** Date Approved
Richard Paine	, Member	**4/9/2012** Date Approved
Eric Hinderaker	, Member	**4/4/2012** Date Approved

and by **Dennis O'Rourke** , Chair of

the Department of **Anthropology**

and by Charles A. Wight, Dean of The Graduate School.

ABSTRACT

This study will test the correspondence of relatedness with mortality risk in the founding population of Jamestown Colony. Previous research on other early colonies suggests that individuals with a higher level of relatedness will have a lower mortality risk. The study will also look at possible correlations of mortality risk with age and social status of the founding population as well as fertility levels of the survivors. Finally, the study will compare the Jamestown Colony with the Plymouth Colony to see if the correspondence of relatedness to mortality risk is a common factor in general among founding populations or only a factor in certain founding populations. This study will examine the hypothesis that individuals in the Jamestown Colony that have a higher level of relatedness will have a lower level of mortality like the Plymouth Colony. A secondary hypothesis to be tested is to determine if, among the survivors, those individuals with relatives would have higher fertility than those individuals that had no relatives.

TABLE OF CONTENTS

LIST OF TABLES

Table **Page**

ACKNOWLEDGEMENTS

I thank John McCullough, Henry Harpending, Dennis O'Rourke, Richard Paine and Eric Hinderaker for help and comments.

INTRODUCTION

Definition

A founding population can be defined as a population that settles a new geographical region that is not currently populated. A founding population is established by a small number of individuals from a larger, parent population. Founding populations have a reduced set of genes compared to the parent population. Founding populations then become subject to the founder effect. The founder effect is the loss of genetic variation that occurs in a founding population or when an impoverished set of genes is present (Wright, 1942).

Founders and founding populations have formed an important part of human genetic history and prehistory. As humans have expanded into new territories throughout their history they have done so as founding populations. The "Out-of-Africa Replacement Model" or "Single Origin Model" states that modern humans originated in Africa around 150,000 years ago (Stringer and Andrews, 1988). Between 125,000 and 60,000 years ago humans first migrated out of Africa and spread throughout the rest of the world. It is hypothesized that there were at least three major migrations of hominid populations from Africa during the Pleistocene. The final set of migrations was of anatomically modern humans. The founding populations of these modern humans spread into the new areas as colonists and likely displaced the earlier, premodern populations through extinction and some limited interbreeding.

Founding populations are not ordinarily formed from random unrelated individuals, but are at least partly related (Meggitt 1962, Chagnon 1975, McCullough and Barton, 1990). Because of this, Sewall Wright predicted that founding populations would suffer a loss of genetic variation when compared with the parent population (Wright, 1942). As a result the founding population may be significantly genetically different from the original parent population. The founder effect has been used to help understand how certain genetic traits have been expressed and spread through a population in greater numbers than would be explained by selection alone. One such example is the prevalence of the Ellis-van Creveld Syndrome in the Amish population in Pennsylvania. The Amish migration to Pennsylvania in the mid-1700s has been described as a founding population. The Amish colony tended to be isolated and high levels of inbreeding occurred. As a result the Ellis-van Creveld Syndrome is more prominent in the Amish community than in the general population (Cavalli-Sforza, Menozzi and Piazza, 1996).

Founding populations have also contributed to the study of population dynamics. Population dynamics studies how populations are affected by birth, death, immigration and emigration. Founding populations are a direct result of the process of migration. There are three kinds of founding populations, fission/fusion, migration/expanding and geographic isolates (Wright, 1942).

Fission/fusion founding populations are defined as internal founding groups within an already established population. At times the settlement size of the established population gets large enough that the settlement will split, at least partially, along kin lines with one group staying at their present location and the other group migrating to an unoccupied area near the original population to establish a new settlement. The larger

group fissions into two smaller groups. These fissioning populations are a form of kin-structured migration first described by Alan Fix. His model is based on the principle that there is a common tendency for kin to associate and cooperate and therefore, migrate together (Fix, 2004). At other times settlements will be smaller and less viable socially thus more vulnerable to attacks by enemies. The smaller settlements will fuse together, again usually with closely related settlements to form a larger, more secure settlement. This form of migration is known as fusion.

A migration/expanding founding population usually travels a great distance and settles in a new area that is unknown to the individuals settling the population. They also typically have new individuals constantly migrating to the population over time.

Geographic isolate founding populations are characterized by a group of individuals that settle an area that is geographically isolated from more populous regions. There is little or no migration into the population in the years after the founding event.

Each kind of founding population is characterized by different fertility and mortality patterns as compared to the others (Mayer, 1954). Since founding populations are much smaller than parent populations, changes in the dynamics of the population can be more readily seen and studied. Understanding these changes in founding populations can help demographers and geneticists begin to understand the processes and changes that may have occurred in past human populations (Wright, 1942, Mayer, 1954).

Past Founding Populations

A founding event is often riddled with hardship and difficulty, and it is not an easy task to establish a settlement in a new area. Often the founders are faced with an environment with which they are unfamiliar. The types of plant and animal foods available may be different in the new area. There may be a different growing season for the agriculture of the area. Starvation may be high because the population is not familiar with the new environment. Because of the hardship, mortality is high and not all the original founders of the settlement end up being the genetic founders of the population. Several historical founding populations have been studied and may be used for comparison.

The founding population of Tristan da Cunha is an example of a geographic isolate. Tristan da Cunha is a remote island group in the south Atlantic Ocean. The main island in the chain is named Tristan da Cunha and is the location of the colony. The founding population of Tristan was not from a single migratory event, but was spread out over a period of 90 years. The present descendants are from 22 settler ancestors made up of 15 males and 7 females (Soodyall, et. al, 1997). Tristan da Cunha was originally founded by a British Marine garrison as a fort. The British looked to prevent the French from using the island as a base in which to free Napoleon Bonaparte from the island of St. Helena. Several migratory events followed in which the purpose of the migration was for settling a community. These migratory events included both men and women. The island is very mountainous, but has a subtropical climate with a long growing season. The population was able to grow enough food to maintain itself as well as an abundant supply of food from the ocean so starvation did not seem to be a problem. The first

generation had the highest fertility, partly because the generation was spread out over so many years and partly due to the fact that many of the later generations had high out migration rates among the males. The island was a popular stopping point for whaling vessels and many young men would leave the island with the whaling vessels. No detailed mortality studies have been conducted among the Tristan da Cunha population. However, in 1885, a tragic boating accident occurred in which 15 men from Tristan da Cunha were lost at sea. The accident left 13 widows on the island and only 4 adult men. This significant reduction in genetic variation was a major contributor in the genetic makeup of the current population (Roberts, 1971).

The Plymouth Colony in New England is an example of a migration/expanding founding population. The Plymouth Colony was settled by men, women and children. There were several families in the first voyages that came to Plymouth (McCullough and Barton). The purpose of the Plymouth colonization was for creating a new home where the settlers could practice their religion free from the oppressive constraints of the Church of England. The Plymouth colonists experienced difficult circumstances during their founding. There was high mortality due to extreme cold climatic conditions during the first winter. There was little food and the cold climatic conditions worsened the situation (McCullough and Barton, 1990). In Plymouth 53 of the first 103 original settlers died during the first winter. Because the Plymouth Colony was founded by many families, the level of relatedness in the Colony was high. Relatedness has been shown to be important during times of stress, like the harsh conditions experienced in Plymouth in the first winter. Another example was demonstrated in the Yanomamö, during the famous ax fight described by Chagnon and Bugos (1979). During the ax fight relatives clustered

together for support. The fight escalated enough that one individual was knocked unconscious. However, each group had enough support from relatives that the fight was soon over with no loss of life.

Another group that experienced hardships similar to those associated with a founding event was the Donner-Reed Party. The Donner-Reed Party was a group of pioneers that was emigrating to California in a wagon train. They were stranded in the Sierra Nevadas during the winter of 1846-1847. The group was made up of 87 people, mostly families with their children and some hired hands (Rarick, 2008). The Donner-Reed Party experienced similar mortality to that experienced during the first winter of the Plymouth Colony with 40 of the 87 settlers dead by the end of winter in 1847. Most of these deaths can be attributed to starvation, extended malnutrition, murder, overwork and exposure to the cold from the severe winter and lack of food. The three most important factors in the survival of the 47 remaining members of the party were age, sex and the family group size. Children between 6 and 14 years of age had the highest survival rate of all children. No individual over the age of 49 survived. Females had a higher survival rate than males. Finally, those traveling with family members had higher survival than those traveling alone (Grayson, 1994, Hardesty, 1997).

The Yanamamö of Venezuela is a classic example of the fission/fusion model. They live in small, remote villages in the tropical forests of Venezuela (Chagnon, 1997). The villages are separated by many miles of unoccupied land. They practice slash and burn agriculture. The fields are cultivated for a couple of years and then the population must move on to clear a new field. The old field is left fallow for 20-25 years. The slash and burn agriculture cannot support too large of a population and is the driving force of

fission populations. The Yanomamö villages are structured around kinship. Because populations are structured along kin lines the number of available mates is reduced. There is much intervillage warfare in an effort to obtain mates. The fusion of smaller populations into one larger population is a product of the need for more mates and the need to be protected from other populations during warfare. The Yanomamö reflect a typical population structure of a preindustrial society. Their age/sex distribution is in the shape of a pyramid, in that a large portion of their population falls in the 0-10 year age group with each successive age category becoming smaller. This pyramid reflects a normal mortality pattern for tribal populations with high infant mortality (Chagnon, 1997). The founding populations formed from the fission of a large group would be much smaller in size. They would therefore be more vulnerable to attack from larger, more established villages. The mortality rate would increase due to that vulnerability. The new, smaller villages would be more closely related and therefore may need to form alliances with other villages in order to have a good sized pool of available mates. This may take a while to happen so the fertility would be lower in the first generation because of fewer matings.

Jamestown

The founding population in this study is the Jamestown Colony that was founded in 1607. The Jamestown Colony is an example of a migration/expanding founding population. However, Jamestown was different in several ways from the other founding populations. First, the original purposes for the founding of Jamestown were different from those of Plymouth Colony, Tristan da Cunha or the Yanamamö. One original purpose of the settlement of the Jamestown Colony was for economic exploitation. The

colonists were sent to Jamestown in an effort to find various raw materials that could be exported back to England. The stockholders of the Virginia Company of London who financed the expedition were expecting the colonists to find raw materials like silver and gold to send back to England. They also hoped the colonists would find natural resources that England lacked to send back as well. The Jamestown Colony was mostly an economic venture.

A secondary purpose was for military protection from the Spanish, who threatened colonization from the south in Florida. The Spanish had been in the Western Hemisphere since 1492 and as far north as Florida since 1513. The reasons for the founding of the colony were focused on the individuals who were economically useful to colony purposes more than groups or families. In contrast the primary purposes for the founding of Plymouth, Tristan da Cunha and the Yanamomö all center around the building of a new home as a community.

As the Colony was founded for the purposes of discovering and collecting raw materials and military defense, fulfilling of these purposes logically required young, single men and not the settling of families. Thus, the relatedness of the population would be expected to be low. Jamestown was originally composed of an entirely male population which gave it a highly biased sex ratio. The social composition of the Colony was composed of three classes. The upper class consisted of councilmen and professionals such as doctors. These men were wealthy and were able to finance their voyage on their own. The men from the middle class were usually tradesmen with special skills needed to establish the Colony, including brick layers, jewelers and merchants. The lower class consisted of men who were the laborers. They were

expected to do most of the hard work of building the fort and maintaining it upon arrival. The last two classes relied on the Virginia Company to finance their passage. Therefore, the sex ratio and social composition of Jamestown is different from that of other founding populations.

Jamestown was established in Virginia on the eastern edge of North America. The climate of the Virginia area was different from that of Plymouth in New England, the Sierra-Nevada mountain range where the Donner-Party spent the winter, the semi-tropical island of Tristan da Cunha, the jungles of South America where the Yanamamö reside, or even their home in England. Jamestown was settled in a very marshy, mosquito-infested environment. There was very little drinkable water. The colonists were stricken with diseases from the outset. Though the Jamestown colony did experience winter conditions, they were not as extreme as those of Plymouth or the Sierra-Nevadas.

The challenges that the colonists faced in Jamestown and caused much of the mortality were intestinal disease and starvation. Early on the colonists drank from shallow wells at the fort and directly from the James River. The water was not clean and the diseases were most likely dysentery and typhoid fever, which took the greatest toll on the colonists. In addition the Chesapeake area was in a time of drought. Food supplies ran low early on, and the colony was dependent on re-supply from ships from England. However, the supply ships were delayed by weather. The Colony went through the "Starving Time," during the winter of 1609-1610. There was a severe drought during 1609 that caused crop failure and a poor harvest. Food supplies were considerably low. The colonists also relied on obtaining supplies from the Powhatan people. John Smith

developed a good relationship with the Powhatans. However, he returned to England in 1609 due to a gunpowder accident. With John Smith gone, Chief Powhatan stopped trading with the settlement, further reducing scarce food supplies. The lack of locally grown food, the stoppage of trade with the Powhatans and the delay of the resupply ships from England were the conditions that gave the winter of 1609-1610 the name of the "Starving Time." At the end of the Starving Time only 69 people had survived out of a total of 214 original settlers.

Physical threat from the Powhatan people also existed. Relations between the colonists and the native population were in continual flux. Each side had their own agendas that were diametrically opposed to each other. At times the colonists were able to trade with the Powhatans and other local tribes. However, relations were always filled with tension. The colonists saw themselves as superior to the native tribes and felt that they owned the rights to the land they claimed. The Powhatans and other local tribes wanted to defend the land that they had occupied for centuries. The colonists led the native populations to believe that they were only coming temporarily, but their actions such as fort construction proved differently. The Powhatan people did attack the fort on a number of occasions in an attempt to defend their land. Several colonists were killed in these attacks and during military expeditions to the Powhatan villages (Rountree and Turner, 2002).

While the Plymouth Colony was made up of many families with men, women and children, in contrast, the original Jamestown colonists were all male. At the outset we would expect the level of relatedness should be lower for the Jamestown Colony as compared to the Plymouth Colony because the makeup of the populations was very

different and because of the purpose of the founding of each colony was different. McCullough and Barton's study of relatedness and mortality in the Plymouth Colony showed a higher relatedness in survivors for the total sample and for most subsamples. The results suggest that those with relatives in the Colony played a role in the survival of individuals in the Colony. McCullough and Barton found that the mortality risk for related individuals is lower than for unrelated individuals in the Plymouth Colony of 1620 (McCullough and Barton). This study may further explain the importance of relatedness on the survival of individuals in founding populations in times of crisis. As the mortality rate was sufficiently high during the first 3 years of migration to the Jamestown Colony to allow statistical analysis, a comparison of the mortality rates with relatedness of individuals may show that survivorship is dependent on the level of relatedness of individuals. We hypothesize that the study will show that individuals with a higher level of relatedness will have a lower mortality risk. Moreover, the study will look at the individuals that did survive, both with relatives and those without relatives, and see if their survival had any effect on their fertility. We theorize that the individuals with relatives that survived would have higher fertility than those individuals with no relatives that survived. The benefit of having relatives to survival would carry over and also be a benefit to fertility and also a benefit to the survival and fertility of the next generation. As a consequence their children and grandchildren may have higher rates of survival and fertility. This study will first measure the relatedness of the founding population of the Colony. More importantly the study will investigate whether there is a correlation between relatedness and mortality risk for the population.

HISTORICAL BACKGROUND

The Jamestown colony was founded in 1607 by the English. England at the time was ruled by King James I, but the foundation was laid mostly during the reign of Queen Elizabeth I, the predecessor to King James. Queen Elizabeth began her reign in 1558, succeeding her sister Queen Mary I. After the death of Henry VIII in 1547, England was in political upheaval. When Henry died his son, Edward VI succeeded him to the throne. However, Edward was only 9 years old at the time of his accession, so the country was ruled by a Regency Council. The time was filled with political, economic and social unrest. The Anglican Church was transformed into a Protestant body of religion during this time and Edward was the first monarch raised as a Protestant. England was divided between those that wanted to remain Catholic and those that had embraced the change to the Protestant faith and the Anglican Church formed by Henry VIII. The unrest finally erupted into riots and rebellion in 1549. England also engaged in a war with Scotland during Edward's reign that ended with England withdrawing from Scotland and losing control of the country of Scotland (Alford, 2002).

In 1553 Edward VI fell ill. It was determined that the illness was terminal. Edward and his Regency Council, afraid the country would turn back to Catholicism, set up a will designating Edward's cousin, Lady Jane Grey as his successor. He attempted to cut out his two half-sisters from the throne. Edward died shortly after in 1553. His will was disputed upon his death and Lady Jane Grey was formally Queen for only 9 days

and was then executed for treason. Queen Mary I, Edward's older half-sister, succeeded to the throne in 1553 (Ives, 2009).

The reign of Queen Mary I was filled with more unrest and bloodshed, earning Mary the nickname of "Bloody Mary." She had Lady Jane Grey and her husband executed for treason shortly after ascending to the throne. Mary was raised as Roman Catholic, and as soon as she ascended to the throne she began a campaign to return the country to Catholicism. She imprisoned many of the leading reforming churchmen and abolished Edward's religious laws. She also had almost 300 religious dissenters burned at the stake during her reign, and thus earned her nickname (Eamon, 2009). Queen Mary married the Catholic Prince Philip of Spain, who later became the King of Spain. Much of their marriage they spent separated with Mary in England and Philip in Spain or at war with France. Mary also was unable to bear any children. Even though Mary was married to the King of Spain, England did not benefit from the monopoly that Spain held in world trade. The economic and religious unrest that was prevalent during Edward's reign continued through Mary's reign. Mary fell ill in the spring of 1558 and died during an influenza outbreak in November 1558 (Porter, 2007).

Elizabeth Tudor became Queen Elizabeth I on 17 November 1558, succeeding her half-sister, Mary I. Elizabeth, like her brother Edward, was raised Protestant. Upon ascending to the throne, Elizabeth moved to reinstate the Protestant religion in England. She enacted the Elizabethan Religious Settlement and the Anglican Church evolved into the Church of England. Elizabeth never married, despite numerous requests from Parliament and many courtships and proposals. It has been suspected that by not

choosing to form one alliance by marriage, she was able to keep many countries at bay in the hopes of forming an alliance (Collinson, 2007).

Elizabeth ruled with the help of good counsel. She relied heavily on a group of good advisors and counselors. She was more moderate than her father, brother and sister had been, following a strategy of patience and moderation, which served her well in the political realm. After the unstable and short reigns of her brother and sister, her reign was a welcome time of stability and growth for England. Within 20 years of her death her 44 year reign was viewed as a Golden Age for England and came to be known as the Elizabethan Era (Collinson, 2007).

Elizabeth took a mostly defensive action in foreign policy, except for the building up of the naval forces and her involvement in the war with Spain. Eighty percent of the war with Spain was fought at sea. After Francis Drake circumnavigated the globe between 1577 and1580, Elizabeth knighted him. As head of England's naval forces, Drake led a major campaign against the Spanish ports and ships in the Caribbean from 1585-1586. In 1587 he made a successful raid on the port of Cadiz in Spain. He destroyed the Spanish fleet of warships that was expected to attack the *Enterprise of England*. In retaliation Philip II of Spain sent the Spanish Armada to attack the English. In what is considered one of the greatest naval victories in British history, Sir Francis Drake defeated the Armada in 1588 (Somerset, 2003).

The victory was not the end of the war between England and Spain. The war formally continued until 1604. The threat from Spain was still prevalent even after the war was over. The establishment of a colony in the New World was a major concern for the English monarchy. A colony could act as a military base to protect English interests

in the New World and serve as a starting point for further exploration and colonization. The first attempt to establish a colony in the New World by the English was actually before the defeat of the Spanish Armada. Sir Walter Raleigh, one of the Queen's favorite advisors and counselors, had received a charter from Queen Elizabeth that gave him ten years to establish a colony in the New World. He financed and organized the expedition to colonize. Sir Walter Raleigh and the Queen intended that a colony could provide resources and riches from the New World as well as military support and protection from the Spanish. They hoped to capitalize on the New World the way the Spanish had been doing for 200 years. Raleigh had already funded two exploratory expeditions to the eastern coast of North America to discover the best place to establish his colony. In 1587 Raleigh dispatched a group of 150 colonists led by John White to settle on Roanoke Island. In late 1587 John White returned to England to ask for help for the colony to withstand the aggressive natives and for additional supplies. Due to a series of misfortunes White was unable to return to Roanoke Island for 3 years. Upon his return in 1590 he found the colony deserted and no trace of the colonists. The first attempt of the English to colonize North America had mysteriously failed (Miller, 2000).

Another full scale attempt to colonize was not made until Queen Elizabeth had passed away and her successor, James I was in power. The London Company, an English joint stock company, was established by a royal charter from James I in October 1606. The charter was given with the purpose of colonizing North America and establishing settlements along the Eastern seaboard. The London Company put together the voyage that would sail to North America and establish the first permanent colony there for the English to be called Jamestown (Bailyn, 1988). The Company enlisted a voluntary labor

force for the voyage. The members of the voyage signed on under an indenture system. In exchange for 7 years of labor in the Colony the London Company would provide passage, food, protection, and eventual land ownership in the Colony (Craven 1957). The Colony was governed by a president and a seven-member council appointed by the Crown. The first priority for the colonists and the London Company was profit. The Company was hoping to find and cash in on gold and silver deposits in the New World. Unfortunately, the Company would be disappointed in fulfilling that desire. The Company then turned the focus to mast timber for the Royal Navy. The forests of England had been depleted, and the seemingly unending virgin forests of the New World could be used as the source for the ships of the English navy (Craven, 1957). They also looked at exploiting other natural resources, including glass manufacture, pitch and tar. The colonists were unable to spend much time on building the profit of the Company they worked for because their time was spent trying to survive. The Company quickly went into debt. For a time the Company was able to recoup some of its losses through the introduction of tobacco as a cash crop by John Rolfe. High mortality for the colonists, however, continued to plague the Company's purposes and in 1624 King James I changed the status of the Colony to a Royal Colony and ended the London Company's interest in Jamestown and Virginia completely (Craven, 1957).

The second priority for the Colony set by King James I and the London Company was as a defensive military post. Even though a peace treaty with Spain had been signed in 1604, relations with Spain were still strained and the two countries remained in serious economic competition. The colonists were instructed by The London Company to establish the fort at a location that could be defended easily from the navies of the other

European countries, especially Spain (Barbour, 1986). The English hoped to place a settlement in the Western Hemisphere to protect their ships from the Spanish threat. Jamestown Island offered a strategic defensive position against approaches by sea (Horn, 2005). The colony would also serve to protect their economic interests in the Americas. The colony would act as a buffer to halt the Spanish advance farther north and exploiting more of the Americas.

MATERIAL AND METHODS

Sample

The sample consists of the individuals who founded the Jamestown Colony from the first three voyages that colonized the Colony between 1607 and 1610. The Preservation Virginia Society has compiled the ship manifests for these first voyages from John Smith's writings (Barbour, 1986). The records indicate that there were 214 individuals that came and settled in the Jamestown Fort on these first three voyages. The first voyage, known as the Original Settlers, sailed with 104 individuals, of which 86 stayed in Jamestown. The second sailing was known as The First Supply. There were seventy-three individuals who settled at Jamestown from the First Supply. The third sailing was known as The Second Supply and 82 individuals settled at Jamestown from this third sailing. The only individuals included in the sample were those who stayed and settled at the fort. The sailors who worked on the ships and returned when the ships left port were excluded from the sample. The sample was further reduced based on availability of biographical information. Individuals were only included in the final sample if it could be determined that they either were known to be alive or dead by the end of the Starving Time or 1609-1610. Biographical information could be confirmed on only 84 of the 214 individuals. Genealogical information was gathered from family histories, from historical records at the Family History Library in Salt Lake City, UT and from Jamestown Biographies from the Virginia Preservation Society. Comparisons were

made of the differences in relatedness values between survivors and the nonsurvivors. The association of relatedness and mortality was tested. Relatedness values were calculated for each individual in the final sample. The samples were further divided by social class. Social class was based on the occupation of the individual. Three categories of occupation were utilized. The upper class was assigned to those individuals who were recorded as being gentlemen, councilmen, doctors or ministers. These individuals were usually from wealthier families and were able to pay their own way. The middle class was assigned to individuals who were tradesman or skilled workers such as bricklayers, jewelers, merchants, etc. The lower class was assigned to individuals who were recorded as laborers on the ship manifests.

Techniques

Relatedness of the individuals of the founding population was calculated for the individuals included in the final sample. A coefficient of Genetic Relatedness (F) will be calculated for each pair of individuals (Chagnon 1975). Individual F values were determined from the genealogical records for the Jamestown Colony on file at the Family History Library in Salt Lake City and from the records of the Preservation Society. The records for each individual were reviewed to determine their mortality experience: when and how they died. A multiple regression analysis developed by La Buda and DeFries (1990) was used to determine the best predictor of survivorship of the individuals. The dependent variable for the Multiple Regression Analysis was whether or not an individual died by the end of the "Starving Time." A number value of either "1" or "2" was assigned to each individual. A "1" indicated that the individual died by the end of the "Starving Time" and a "2" indicated that the individual lived past the "Starving Time."

The independent variables were whether or not the individual had a relative, which was given a “1” or “2” like the death variable, occupation, age at death and time in colony. The “time in colony” variable was the time in months from arrival to Jamestown until the time the individual left, either by death or immigration. A Discriminant Function Analysis developed by Fisher (1936) was also run to analyze the data. The Discriminant Function Analysis is used for variables that are categorical, which the variables for the dataset are and may give a more robust statistical significance. Finally a Cox Regression Analysis developed by Cox (1972) was run on the dataset. A Cox Regression is a proportional hazard model that looks at the relationship between the time that passes to an event, in this case survival, and the covariates.

To assess the eventual evolutionary success the genealogical records were examined for the children of the final sample. The number of offspring of the survivors was examined to determine their eventual fertility and evolutionary success. Another Multiple Regression Analysis was performed using the fertility R-value as the dependent variable with the relative variable, occupation and death variables as the independent variables.

RESULTS

The basic statistics of the sample were expressed in table format. The table includes the year of birth and death, the age at death and age at arrival to Jamestown, social status based on Occupation, gender, relatives in the Colony and r-value for relatives in the colony and r-value for survivorship (Table 1). The first analysis of the dataset tested for a difference between the survivors and nonsurvivors as to whether or not they had relatives. Table 2 compares the survivors with nonsurvivors and if they had relatives in the Colony or not. Of the total 84 individuals in the sample, 41 lived and 43 died (Table 2). There were fifteen individuals in the sample who had relatives in the Colony. Most of the relationships were of brothers. There was one father-son pair. There was also one brother-sister pair. Finally, there was a set of first cousins and a set of second cousins. Of these 15 individuals who had relatives, 11 lived, which is 73% of the total who had relatives. Of the 69 individuals who had no relatives in the colony, 30 lived, which was only 43% of those with no relative. A Difference of Proportion test was performed on the dataset. The results of the test show that having a relative was significant to survivorship (Table 2).

A Multiple Regression Analysis was run on the dataset to determine if this indication was statistically significant in relation to other variables. The dependent variable was Died (this was a variable of whether or not the individual died or lived during the “Starving Time”). The independent variables were Relative (having a relative

Table 1

Jamestown Colonists Basic Statistics

Name	Sex	Birth Date	Death Date	Died	Age at death	Age at arrival	Occ Code	Relative	Time in Colony 2	r- value	# of children	r-value 2
Edward /Gurganay/	M	1574	1609	1	35	33	3	1	22	0.656	0	0
George /Forest/	M		1607	1			1	1	5	1	0	0
Matthew /Scrivner/	M	1588	1607	1	19	19	1	1	3	0.5	0	0
Michael /Pettiplace/Fettiplace/Phetyplace	M	1572	1607	1	35	35	3	1	3	0.656	5	2.5
Michael /Sicklemore	M	1590	1609	1	19	18	3	2	18	0	0	0
Richard /Featherstone	M	1586	1609	1	23	22	3	2	18	0	0	0
Richard /Killingbeck	M		1609	1			3	2	18	0	0	0
Richard /Potts/	M	1574	1608	1	34	34	3	2	9	0	0	0
Thomas /Savage/	M	1585	1607	1	22	22	3	2	4	0	0	0
William /Cantrell/Cantrill	M	1564	1607	1	43	43	3	2	3	0	1	0.5
William /Phettiplace/Fettiplace/Phetyplace	M	1566	1607	1	41	41	3	2	3	0	0	0
William /Spence/	M	1582	1607	1	25	25	3	2	3	0	0	0
Nathaniel /Causey/	M	1560	1607	1	47	47	3	2	3	0	5	2.5
Jeffrey /Abbott/	M		1607	1			1	2	3	0	1	0.5
Thomas /Savage/	M	1570	1607	1	37	37	3	2	4	0	0	0
Anthony /Gosnold/	M		1607	1			3	2	3	0	0	0
Anthony /Gosnoll/ or Gosnold	M	1575	1609	1	34	32	3	2	30	0	0	0
Benjamin /Best/Beast	M		1607	1			3	2	3	0	0	0
Drue /Pickhouse/ or Piggas	M		1607	1			3	2	3	0	0	0
Edward /Browne/	M	1588	1607	1	19	19	3	2	3	0	0	0
Edward /Harrington	M		1607	1			3	2	7	0	0	0
Edward /Morish/Morris	M	1576	1607	1	31	31	3	2	3	0	0	0
Edward /Short/Old Edward	M	1557	1607	1	50	50	3	2	3	0	0	0
Ellis /Kingston/Kiniston	M	1590	1607	1	17	17	3	2	4	0	0	0
Francis /Midwinter	M	1569	1608	1	39	38	3	2	12	0	2	1
Gabriell /Archer/	M	1587	1607	1	20	20	3	2	3	0	0	0
George /Cassen/	M	1585	1607	1	22	22	3	2	3	0	0	0
George /Flower/	M	1583	1607	1	24	24	2	2	7	0	0	0
George /Percy/	M	1581	1607	1	26	26	3	2	3	0	0	0
James /Read/	M	1586	1607	1	21	21	2	2	4	0	0	0
Jeremy /Alicock/	M	1589	1607	1	18	18	1	2	3	0	0	0
John /Asbie/	M		1607	1			3	2	4	0	0	0
John /Dod/	M	1583	1607	1	24	24	3	2	3	0	0	0
John /Martin/ Jr.	M	1582	1607	1	25	25	3	2	1	0	0	0
John /Martin/ Sr.	M	1562	1607	1	45	45	3	2	4	0	3	1.5
John /Robinson/ or Jehu	M		1607	1			1	2	3	0	0	0
John /Waler/	M	1570	1607	1	37	37	3	2	7	0	0	0
Kellem /Throgmorton or Kenelm	M	1567	1609	1	42	40	3	2	28	0	0	0
Nathaniel /Powell/	M	1567	1607	1	40	40	3	2	4	0	0	0
Richard /Simons/	M		1609	1			3	2	6	0	0	0
Robert /Behetheland	M	1570	1609	1	39	38	3	2	6	0	0	0

Table 1 Continued

Name	Sex	Birth Date	Death Date	Died	Age at death	Age at arrival	Occ Code	Relative	Time in Colony 2	r- value	# of children	r-value 2
Robert /Hunt/	M	1577	1609	1	32	31	3	2	3	0	0	0
Robert /Penington/	M		1609	1			3	2	14	0	0	0
Samuel /Collier/	M	1582	1640	2	58	26	3	1	27	0.5	0	0
Stephen /Galthorpe/Calthorpe	M	1584	1656	2	72		3	1	27	0.5	0	
Thomas /Emry/	M	1560	1632	2	72	47	3	1	36	0.5	2	1
Thomas /Gore/Gower	M	1577	1623	2	46	30	3	1	36	0.5	6	3
Thomas /Jacob/	M	1550	1613	2	63	57	3	1	11	0.094	0	0
Thomas /Mounslie/	M	1588	1624	2	36	19	3	1	36	0.281	0	0
Thomas /Mouton/	M	1585	1612	2	27	23	3	1	19	0.5	0	0
Thomas /Sand(y)s/Sands	M	1587	1612	2	25	21	3	1	19	0.5	0	0
Thomas /Studley/	M	1586	1634	2	48	22	3	1	19	1.5	2	1
Thomas /Webb/	M	1594	1624	2			2	1	19	0.5	4	2
Thomas /Wooten/Wotten	M	1578	1627	2	49	30	2	1	19	0.5	0	0
Ustis /Clovill/ or Eustace	M	1576	1618	2	42	32	3	2	27	0	0	0
William /Brewster/	M		1618	2			3	2	27	0	0	0
William/Powell	M		1612	2			3	2	27	0	0	0
William /Rods/Rodes/Roods	M	1592	1624	2	32		1	2	27	0	2	1
William /Tankard/	M	1575	1619	2	44		3	2	27	0	0	
Bartholomew /Gosnoll or Gosnold	M		1623	2			1	2	27	0	1	0.5
Edward Maria /Wingfield	M		1624	2			3	2	27	0	1	0.5
George /Kendall/	M	1579	1612	2	33	29	3	2	27	0	0	0
John /Laydon/	M	1595	1632	2	70	13	1	2	27	0	0	0
John /Ratcliffe/	M	1588	1624	2	36	20	3	2	36	0	0	0
John /Smith/	M	1580	1632	2	52	27	3	2	36	0	0	0
Anthony /Gosnold/Gosnoll	M	1588	1622	2	34	19	2	2	36	0	0	0
George /Walker/	M	1588	1652	2	64	19	1	2	36	0	2	1
Nathaniel /Peacock	M	1587	1622	2	35	20	3	2	36	0	1	0.5
Daniel /Tucker/	M		1628	2			3	2	36	0	3	1.5
David /Ellis/	M	1584	1622	2	38	23	1	2	36	0	0	0
Gabriel /Beadle/Bedell	M	1568	1633	2	65	39	3	2	36	0	1	0.5
Henry /Leigh/Ley/Lee	M		1620	2			3	2	36	0	0	0
Henry /Philpot/	M	1585	1638	2	53	22	3	2	36	0	0	0
John /Beadle/	M	1561	1610	2	49	46	3	2	36	0	0	0
John /Clarke/	M	1580	1625	2	45	27	1	2	36	0	4	2
Peter /Wynne/Winne	M	1580	1631	2	51	27	3	2	24	0	0	0
Richard /Waldo/	M	1599	1632	2	33	8	1	2	36	0	0	0
Thomas /Dowse/	M	1575	1625	2	50	33	3	2	19	0	0	0
Thomas /Graves/	M		1624	2			2	2	19	0	0	0
William /Dowman/Downeman	M		1620	2			3	2	19	0	0	0
Francis /West/	M	1577	1623	2	46	31	2	2	19	0	1	0.5
Raleigh /Croshaw/	M		1619	2			1	2	19	0	0	0
Anne /Burras/	F	1587	1635	2	48	21	3	2	19	0	6	3
John /Burras/	M	1570	1624	2	54	38	3	2	19	0	2	1

Table 2

Relatives/No Relatives of Colonists

Relatives	# no Relatives	# Relatives	Total
Pre Starving	69	15	84
Post Starving - Lived	30	11	41
Post Starving - Dead	39	4	43

Number of individuals who had relatives
and number of individuals who had no relatives.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.395	1	.036		
Continuity Correction	3.282	1	.070		
Likelihood Ratio	4.527	1	.033		
Fisher's Exact Test				.047	.034
Linear-by-Linear Association	4.343	1	.037		
N of Valid Cases	84				

or not), Occupation, Age at Death and Time in Colony. The results of the multiple regression analysis showed that the independent variables accounted for 76% of the variance and that having a relative was significant at the 0.05 level, while the others were not significant at the 0.05 level. The results of the multiple regression analysis are in Table 3. A Discriminant Function Analysis was then run to verify the significance. In the Discriminant Function Analysis the Relative variable again accounted for most of the variance. The results of the Discriminant Function Analysis are in Table 4.

Finally a Cox Regression was performed on the dataset. The time in the Colony in months was the time variable in the Cox Regression. The time in the colony was calculated based on the date of arrival in the Colony until the colonists left the Colony by either death or migration. "Died" was the status variable and "Relative" and "Occupation" were the covariates. The results of the Cox Regression are in Table 5. The Relative covariate was a significant factor in the model, but only at a level of .079 instead of a 0.05 level. Though not significant at the 0.05 level, again having a relative was an important factor on the survival of the colonists. All three analyses run support the hypothesis that having a relative in the Colony improved the chance of survival and it is was significant at the 0.05 level for both the Multiple Regression Analysis and Discriminant Function Analysis. The Cox Regression Hazard model was just above the 0.05 significance level.

A second level of tests was run on the fertility of the sample, on whether or not relatedness of the individuals in the sample had an influence on fertility. The sample was first analyzed in table format to give an overall view of the sample. The results are shown in Table 6. The table seems to indicate that having a relative did not necessarily

Table 3

Multiple Regression Analysis 1

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8585.592	4	2146.398	44.968	.000[a]
	Residual	2625.258	55	47.732		
	Total	11210.850	59			

a. Predictors: (Constant), Time_in_Colony, r_value, Age_at_arrival, Occ_Code

b. Dependent Variable: Age_at_death

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	5.682	4.525		1.256	.215
	Age_at_arrival	.926	.099	.680	9.332	.000
	Occ_Code	-.582	1.569	-.029	-.371	.712
	r_value	.291	3.475	.006	.084	.933
	Time_in_Colony	1.005	.097	.761	10.402	.000

a. Dependent Variable: Age_at_death

Table 4

Discriminant Function Analysis

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1.409[a]	100.0	100.0	.765

a. First 1 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.415	70.776	3	.000

Standardized Canonical Discriminant Function Coefficients

	Function 1
Relative	-.326
Occ_Code	.137
Time_in_Colony	1.018

Table 5

Cox Regression

Omnibus Tests of Model Coefficients
-2 Log Likelihood
356.075

Omnibus Tests of Model Coefficients[a,b]

-2 Log	Overall (score)			Change From Previous Step			Change From Previous Block		
Likelihood	Chi-square	df	Sig.	Chi-square	df	Sig.	Chi-square	df	Sig.
350.605	4.780	2	.092	5.470	2	.065	5.470	2	.065

a. Beginning Block Number 0, initial Log Likelihood function: -2 Log likelihood: 356.075

b. Beginning Block Number 1. Method = Enter

Variables in the Equation

	B	SE	Wald	Df	Sig.	Exp(B)
Relative	.923	.526	3.078	1	.079	2.517
OccCode	.306	.239	1.642	1	.200	1.358

Table 6

Fertility of Colonists

Fertility	Children	No Children
Lived-Relative	4	7
Lived-No Relative	11	19
Died-Relative	1	3
Died-No Relative	5	34

Individuals in the colony that had offspring or not corresponding to if they had a relative or not.

give an advantage in fertility. In fact the opposite almost seems true. Of the individuals with relatives only four individuals who lived and one who died had any children at all. However, almost 75% of the total of individuals who had children were those who had no relative at all. A Multiple Regression Analysis was run with the fertility R-value as the dependent variable and Relative, Occupation and Died as the independent variables. The results showed that there was a negative correlation between fertility and Relative, as indicated in Table 6 and that it was significant at the 0.05 level. The results of the Multiple Regression Analysis are expressed in Table 7.

Table 7

Multiple Regression Analysis 2

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.271[a]	.073	.038	.702

a. Predictors: (Constant), Died, Occ Code, Relative

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.045	3	1.015	2.057	.113[a]
	Residual	38.482	78	.493		
	Total	41.527	81			

a. Predictors: (Constant), Died, Occ Code, Relative

b. Dependent Variable: r-value 2

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.631	.596		1.060	.293
	Relative	-.347	.211	-.183	-1.642	.105
	Occ Code	-.002	.106	-.002	-.015	.988
	Died	.232	.162	.163	1.438	.154

a. Dependent Variable: r-value 2

Correlations

		r-value 2	Relative	Occ Code	Died
r-value 2	Pearson Correlation	1	-.219*	-.033	.203
	Sig. (2-tailed)		.048	.769	.067
	N	82	82	82	82
Relative	Pearson Correlation	-.219*	1	.004	-.229*
	Sig. (2-tailed)	.048		.968	.036
	N	82	84	84	84
Occ Code	Pearson Correlation	-.033	.004	1	-.157
	Sig. (2-tailed)	.769	.968		.153
	N	82	84	84	84
Died	Pearson Correlation	.203	-.229*	-.157	1
	Sig. (2-tailed)	.067	.036	.153	
	N	82	84	84	84

*. Correlation is significant at the 0.05 level (2-tailed).

DISCUSSION AND CONCLUSION

The original colonists to the Jamestown Colony were men from across several social classes from England. They came to Jamestown for various reasons, including their own economic improvement and adventure or a better life. The London Company's primary purpose for funding the expedition was for economic exploitation of the "virgin" land. Secondarily, the Colony was to act as a military fort to stop the advance of the Spanish up the coast from Florida. These purposes were instrumental in developing the composition of the Colony. Young, male individuals were needed to carry out these purposes.

The overall relatedness of the Colony was low because of the nature of the settlement purpose. Most of the individuals were young, single men, unrelated to each other. However, a small percentage of individuals were related. There were several sets of brothers and cousins as well as one father-son pair. Only 17% of the sample had relatives. Of this 17%, however, over 70% of them survived while only 43% of the individuals who did not have relatives survived. The mortality rate of the entire sample was 50% and was higher than the death rate of the origin population in England (Games 2001). It is statistically significant that the survival rate of those with relatives was much higher than the group as a whole. The higher level of relatedness is clearly associated with a lower risk of mortality. It is logical that kin would be more likely to

help each other than unrelated individuals. Kinship ties were important in England throughout the 16th and 17th centuries. Especially in wealthier families, individuals used kin relations to improve their standing in society and to gain advantage (Cressy, 1986). Relatedness accounted for most of the variance in mortality. Other factors, such as occupation, age or time in the colony were not significant contributing factors to mortality. The better survivorship of the individuals with relatives strongly indicates that the presence of relatives in the Colony was a major contributing factor to survival through the Starving Time.

The fertility of the individuals in the sample gave some unexpected results. It was hypothesized that individuals with relatives would have had a higher fertility than individuals with no relatives. However, the results indicated that relatedness had a negative correlation with fertility instead of a positive correlation. There were three times as many individuals who had no relatives who had children than there were individuals with relatives who had children. It seems counterintuitive that survivors with no relatives would have more offspring as it would be expected that the benefits of having kin on survival would also be beneficial on fertility. To better understand this negative correlation the sex composition of the sample needs to be reviewed. The entire sample except for one individual was male. For the first few years of the Colony's existence few females migrated to the Colony. The pool of possible spouses was small. An individual's relatives were most often also male. The relatives would be competitors for spouses and land. Where an individual would help a kinsman in situations that affect their mortality, such as sickness and starvation, they would also be in competition with the same kin with factors that affect fertility, such as spouse and land. Darwin first

defined this kind of competition as intrasexual competition as part of his theory of sexual selection (Darwin, 1871). Intrasexual selection is the competition between members of the same sex for mating access to members of the opposite sex. David Buss in his study of human intrasexual competition found that men more frequently used tactics of male-male competition that involved resource possession and display (Buss, 1988). Several studies of male-male competition and reproductive success have been conducted. In a study of Mormon polygamist societies from the 1850s – 1870s it was shown that a male's ability to gain access to and control resources allowed for greater access to mates and thus higher reproductive success (Heath and Hadley, 1998). Studies of the Gabbra pastoralists and the Mukogodo of Kenya show that the access or accumulation of wealth is correlated with male reproductive success. Wealthier men with larger camel or cattle herds had higher reproductive success. Among the Gabbra, men with more elder brothers had smaller herds, married later, and had lower reproductive success (Mace, 1996, Cronk, 1991). Similar to the Gabbra, in Jamestown relatives had a tendency to live close to each other, reducing the amount of available resources (i.e., land) close by that each individual relative might have available to them. Competition for that resource would then be greater between relatives than nonrelatives who lived farther apart. The amount of the resource individuals with relatives could display as their own would be less than the amount an independent individual could display. Those individuals with relatives, then, would be less likely to obtain a mate than those without relatives. Therefore, having a relative could lower an individual's reproductive success. This could lead to the negative correlation seen in the sample.

The fertility results are complicated by a possible correlation to the location of where the children of the sample individuals were born. The fertility data represent three categories of offspring. The three conditions are fertility in England, those individuals who had children in England before they migrated, fertility in Virginia, those individuals who had children in Virginia after they migrated, and fertility in both, those individuals who had children in both locations. Table 8 shows the breakdown into the three categories by location. A question arises as to whether the presence of children in England served as a detriment to migrating or as an incentive to migrate and seek a fortune. Though the sample size is too small to run a full analysis, several interesting results can be seen in a review of the table. Only two of the individuals had children only in England before they migrated to Virginia. Three more individuals had children before they migrated. Then their spouse migrated and they had more children later. The majority of the individuals was unmarried and had no offspring before they migrated to Virginia.

The individuals who already had children in England before they migrated were relatively older when they came and all came from the upper two classes. One individual was a tradesman and the other four were gentlemen/councilors. They appeared to be better off because they could afford to come and pay for the trip themselves. It is evident that the presence of children in England was not an incentive to come to Virginia. It does not appear that those individuals came to Virginia to seek a fortune to support their families. It is more likely that having a family was more of a detriment to coming to Virginia. Most of the individuals that migrated were single, young men. The journey was long and risky. Those individuals with families would have a more stable life and be

less likely to want to leave their families for such a risky journey. The data indicate that the majority of individuals, roughly 67%, that migrated, survived and had children were unmarried and with no children at the time of migration. Those individuals without families already were more free to come and begin a new life and family in Virginia. The presence of relatives in the Jamestown Colony was a significant factor in the survival of individuals. The difference between the composition of the founding population of the Plymouth Colony and the Jamestown Colony was important in determining if the correlation between relatedness and mortality found in Plymouth could be extended to other founding populations. The Jamestown Colony was very different from the Plymouth Colony. The higher relatedness among survivors in Jamestown further suggests that having relatives in founding populations is a significant factor on mortality, as first suggested in the Plymouth Colony.

Table 8

Fertility by Location

Fertility by Location

	Relative	No Relative
England	1	1
Virginia	2	8
Both	1	2

Location of birthplace
of offspring for
individuals who survived.

REFERENCES

Alford, Stephen
2002 Kingship and Politics in the Reign of Edward VI. Cambridge: Cambridge University Press.

Bailyn, Bernard
1988 The Peopling of British North America: An Introduction. New York: Vintage Press.

Barbour, Philip
1986 The Complete Works of Captain John Smith. Chapel Hill: University of North Carolina Press.

Buss, David
1988 The Evolution of Human Intrasexual Competition: Tactics of Mate Attraction. Journal of Personality and Social Psychology 54(4):616-628.

Cavalli-Sforza, L. L. with Paolo Menozzi and Alberto Piazza
1996 The History and Geography of Human Genes. Princeton: Princeton University Press.

Chagnon, N.A.
1975 Genealogy, Solidarity, and Relatedness: Limits to Local Group Size and Patterns of Fissioning in an Expanding Population. Yearbook of Physical Anthropology 19:95-110.

Chagnon, N.A.
1997 Yanomamö. Fort Worth: Harcourt Brace College Publishers.

Chagnon, N. A. and P. Bugos
1979 Kin Selection and Conflict: An Analysis of a Yanomamö Ax Fight. *In* Evolutionary Biology and Human Social Behavior: An Anthropological Perspective. N. A. Chagnon and W. Irons, eds. Pp. 213-237. North Sciuate: Dixbury Press.

Collinson, Patrick
2007 Elizabeth I. Oxford: Oxford University Press.

Cox, D. R.
1972 Regression Models and Life-tables. Journal of the Royal Statistical Society 34:187-220.

Craven, Wesley Frank
1957 The Virginia Company of London, 1606-1624. Charlottesville: The University of Virginia Press.

Cressy, D.
1986 Kinship and Kin Interaction in Early Modern England. Past and Present 113:38-69.

Cronk, L.
1991 Wealth Status and Reproductive Success Among the Mukogodo of Kenya. American Anthropologist 932:345-360.

Darwin, C.
1871 The Descent of Man and Selection in Relation to Sex. London: Murray.

Eamon, Duffy.
2009 Fires of Faith: Catholic England under Mary Tudor. New Haven: Yale University Press.

Fisher, Ronald.
1936 The Use of Multiple Measurements in Taxonomic Problems. Annals of Eugenics 179-188.

Fix, Alan
2004 Kin-Structured Migration: Causes and Consequences. American Journal of Human Biology 16:387-394.

Games, Alison
2001 Migration and the Origin of the English Atlantic World. Cambridge: Harvard University Press.

Grayson, Donald K.
1994 Differential Mortality and the Donner Party Disaster. Evolutionary Anthropology 2:151-159.

Hardesty, Donald
1997 The Archaeology of the Donner Party**.** Las Vegas: University of Nevada Press.

Heath, Kathleen Marie and Craig Hadley
1998 Dichotomous Male Reproductive Strategies in a Polygynous Human Society: Mating Versus Parental Effort. Current Anthropology 30(3):369-374.

Horn, James
2005 A Land as God Made It. New York: Perseus Books.

Ives, Eric
2009 Lady Jane Grey, a Tudor Mystery. Chichester: Wiley-Blackwell Press.

LaBuda, M.C. and J.C. DeFries
1990 Genetic Etiology of Reading Disability: Evidence from a Twin Study. Perspectives on Dyslexia 1:47-76.

Loudon, J.B.
1975 Early Travelers to Tristan da Cunha. *In* Studies in African Social Anthropology Pp. 140. New York: Academic Press.

Mace, R.
1996 Biased Parental Investment and Reproductive Success in Gabbra Pastoralists. Behavioral Ecology and Sociobiology 38:75-81.

Mayr, Ernest
1954 Change of Genetic Environment and Evolution. *In* Evolution as a Process. J. Huxley, A. C. Hardy and E. B. Ford eds. Pp. 157-180. London: Allen and Unwin.

McCullough, J and E. Barton
In press Relatedness and Mortality Risk During a Crisis Year: Plymouth Colony, 1620-21. Ethology and Sociobiology.

Megitt, M.
1962 Growth and Declined in Agnatic Descent Groups Among the Mae Enga of the New Guinea Highlands. Ethnology 1(2):158-165.

Miller, Lee
2000 Roanoke: Solving the Mystery of the Lost Island. New York: Arcade Publishing.

Norusis, M.J.
1988 SPSS/PC+ Advanced Statistics V2.0 for the IBM PC/XT/AT and PS/2. Chicago: SPSS, Inc.

Porter, Linda
2007 Mary Tudor: The First Queen. London: Little, Brown Press.

Rarick, Ethan
2008 Desperate Passage: The Donner Party's Perilous Journey West. Oxford: Oxford University Press.

Roberts, D.F.
1971 The Demography of Tristan da Cunha. Population Genetics 25(3):465-479.

Rountree, Helen and Randolph Turner, III
2002 Before and After Jamestown: Virginia's Powhatans and their Predecessors. Gainesville: University Press of Florida.

Somerst, Anne
2003 Elizabeth I. London: Anchor Books.

Soodyall, Himla with Trefor Jenkins, Arindam Mukherjeem Ernette du Toit, Derek F. Roberts and Mark Stoneking
1997 The Founding Mitochondrial DNA Lineages of Tristan da Cunha Islanders. American Journal of Physical Anthropology 104:157-166.

Stringer, C and P Andrews
1988 Genetic and Fossil Evidence for the Origin of Modern Humans. Science 239: 1263-1268.

Wright, S.
1942 Statistical Genetics and Evolution. Bulletin of the American Math Society 48: 223-246.